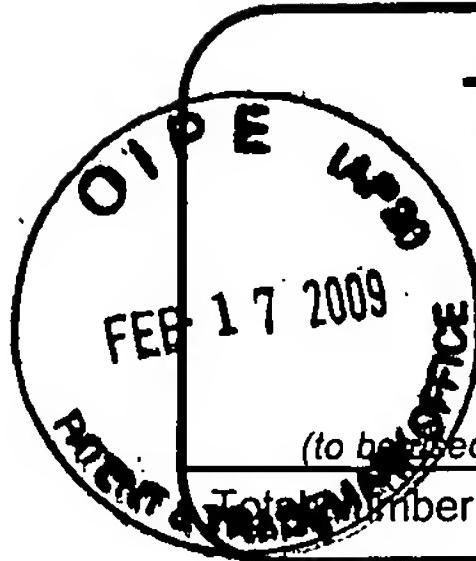


Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.



# TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission

Application Number	10/584,605
Filing Date	August 9, 2007
First Named Inventor	David William LEEMING
Art Unit	3662
Examiner Name	
Attorney Docket Number	58473-348144

## ENCLOSURES (check all that apply)

<input type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached <input type="checkbox"/> Amendment / Reply <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input type="checkbox"/> Information Disclosure Statement <input checked="" type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Reply to Missing Parts/ Incomplete Application <input type="checkbox"/> Reply to Missing Parts under 37 CFR1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert to a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s) _____ <input type="checkbox"/> Landscape Table on CD	<input type="checkbox"/> After Allowance Communication to TC <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input type="checkbox"/> Other Enclosure(s) (please identify below):
<b>Remarks</b>		

## SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Kilpatrick Stockton LLP		
Signature			
Printed Name	Dean W. Russell		
Date	12 February 2009	Reg. No.	33452

## CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop Licensing & Review, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Signature			
Typed or printed name	Angela M. Rossi	Date	13 FEBRUARY 2009

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

**RECEIVED**  
**OIPE/IAP**

FEB 26 2009

**INTELLECTUAL  
PROPERTY OFFICE**

Concept House  
Cardiff Road  
Newport  
South Wales  
NP10 8QQ

The undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents originally filed in connection with patent application GB0601030.0 filed on 17 January 2006.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, p.l.c. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

W.M.  
Patent Office  
SAV

Signed

*William Morell*

Dated 5 January 2009

17 JAN 2006

RECEIVED BY POST

**Request for grant of a patent**(An explanatory leaflet on how to fill in this form is available  
from the Patent Office)**Application number GB****0601030.0**J164886/ 002 D01914 P01/77FEE.....  
19JAN06 30.00 CHEQUE 0601030.0

The Patent Office

Cardiff Road  
Newport  
South Wales  
NP10 8QQ1. Your reference:  
(optional)

CSM/68543/002

2. Full name, address and postcode of the applicant  
or of each applicant (*underline all surnames*):AMSAFE Bridport Limited  
The Court  
Bridport  
Dorset DT6 3QU  
United Kingdom (UK)

08512279002

Patents ADP number (*if you know it*):If the applicant is a corporate body, give the  
country/state of its incorporation:

United Kingdom (GB)

3. Title of the invention:

TEXTILE ARMOUR

4. Name of your agent (*if you have one*):PAGE HARGRAVE  
Southgate, Whitefriars  
Lewins Mead  
BRISTOL BS1 2NT"Address for service" in the United Kingdom  
to which all correspondence should be sent  
(*including the postcode*)Patents ADP number (*if you know it*):

05996483001

5. Priority declaration: Are you claiming  
priority from one or more earlier-filed  
patent applications? If so, please give  
details of the application(s):

Country	Application number ( <i>if you know it</i> )	Date of filing ( <i>day / month / year</i> )
GB	0500854.5	17/11/2005

6. Divisionals etc: Is this application a divisional  
application, or being made following resolution  
of an entitlement dispute about an earlier  
application? If so, please give the application  
number and filing date of the earlier application:Number of earlier UK application      Date of filing  
(*day / month / year*)

7. Inventorship: (Inventors must be individuals not companies)

(Please tick the appropriate boxes)

Are all the applicants named above also inventors?

YES  NO 

If yes, are there any other inventors?

YES  NO 

8. Are you paying the application fee with this form?

YES  NO

# Patents Form 1/77

9. Accompanying documents: not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form:

Description: 13 ✓

Claim(s): 3 ✓

Abstract: 1 ✓

Drawing(s): 3 + 3

If you are not filing a description, please give details of the previous application you are going to rely upon:

Country

Application number

Date of filing  
(day / month / year)

10. If you are also filing any of the following, state how many against each item.

Priority documents:

Statement of inventorship and right to grant of a patent (Patents Form 7/77): Two ✓

Request for search (Patents Form 9A/77): One ✓

Request for substantive examination (Patents Form 10/77):

Any other documents:  
(please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature(s):   
PAGE HARGRAVE Date: 16/01/2006

12. Name, e-mail address, telephone, Fax and/or mobile number, if any, of a contact point for the applicant:

Mr C S Macpherson  
Tel:(0117) 927 6634 Fax: 0117 929 8007  
e-mail: bristol@pagehargrave.co.uk

## Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you are resident in the United Kingdom and your application contains information which relates to military technology, or would be prejudicial to national security or the safety of the public, section 23 of the Patents Act 1977 prohibits you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

## Notes

A leaflet on how to fill in this form is available from the Patent Office. If you would like a copy of the leaflet it is available on our website at <http://www.patent.gov.uk/patent/info/fact05.pdf> or alternatively you could telephone 08459 500505 or send an email to [enquiries@patent.gov.uk](mailto:enquiries@patent.gov.uk) to request a copy.



**Statement of inventorship and of  
right to grant of a patent**

The Patent Office

Cardiff Road  
Newport  
South Wales  
NP9 1RH

1. Your reference

CSM/68543/002

2. Patent application number

(if you know it)

0601030.0

3. Full name of the or of each applicant

AMSAFE Bridport Limited

4. Title of the invention

TEXTILE ARMOUR

5. State how the applicant(s) derived the right  
from the inventor(s) to be granted a patent

By virtue of a contract of employment between  
Ordnance Test Solutions Limited and the Inventor David  
William Leeming and an assignment dated 31 January  
2005 from Ordnance Test Solutions Limited to the  
applicant.

6. How many, if any, additional Patents Forms  
7/77 are attached to this form?  
(see note (c))

7.

I/We believe that the person(s) named over the page (and on  
any extra copies of this form) is/are the inventor(s) of the invention  
which the above patent application relates to.

Signature

Date 16/01/2006

PAGE HARGRAVE

8. Name and daytime telephone number of  
person to contact in the United Kingdom

Mr C S Macpherson (0117) 927 6634

**Notes**

- a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- b) Write your answers in capital letters using black ink or you may type them.
- c) If there are more than three inventors, please write the names and addresses of the other inventors on the back of another Patents Form 7/77 and attach it to this form.
- d) When an application does not declare any priority, or declares priority from an earlier UK application, you must provide enough copies of this form so that the Patent Office can send one to each inventor who is not an applicant.
- e) Once you have filled in the form you must remember to sign and date it.

Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

09836248001

**David William Leeming**  
**1 Swindon Road**  
**Old Town**  
**Swindon SN1 3JJ**  
**United Kingdom (GB)**

Patents ADP number (*if you know it*):

Patents ADP number (*if you know it*):

Patents ADP number (*if you know it*):

**Reminder**

**Have you signed the form?**



## Statement of inventorship and of right to grant of a patent

The Patent Office

 Cardiff Road  
Newport  
South Wales  
NP9 1RH

1. Your reference

CSM/68543/002

2. Patent application number

(if you know it)

0601030.0

3. Full name of the or of each applicant

AMSAFE Bridport Limited

4. Title of the invention

TEXTILE ARMOUR

5. State how the applicant(s) derived the right  
from the inventor(s) to be granted a patent

By virtue of a contract of employment between  
Ordnance Test Solutions Limited and the Inventor David  
William Leeming and an assignment dated 31 January  
2005 from Ordnance Test Solutions Limited to the  
applicant.

6. How many, if any, additional Patents Forms  
7/77 are attached to this form?  
(see note (c))

7.

I/We believe that the person(s) named over the page (and on  
any extra copies of this form) is/are the inventor(s) of the invention  
which the above patent application relates to.

Signature

Date 16/01/2006

PAGE HARGRAVE

8. Name and daytime telephone number of  
person to contact in the United Kingdom

Mr C S Macpherson (0117) 927 6634

**Notes**

- a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- b) Write your answers in capital letters using black ink or you may type them.
- c) If there are more than three inventors, please write the names and addresses of the other inventors on the back of another Patents Form 7/77 and attach it to this form.
- d) When an application does not declare any priority, or declares priority from an earlier UK application, you must provide enough copies of this form so that the Patent Office can send one to each inventor who is not an applicant.
- e) Once you have filled in the form you must remember to sign and date it.

**Patents Form 7/77**

Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

**David William Leeming  
1 Swindon Road  
Old Town  
Swindon SN1 3JJ  
United Kingdom (GB)**

Patents ADP number (*if you know it*):

Patents ADP number (*if you know it*):

Patents ADP number (*if you know it*):

**Reminder**

**Have you signed the form?**

## Textile Armour

The present invention relates to textile armour and to a textile armour system which may be utilised to protect a vulnerable target, such as a vehicle, building or other object, from damage caused by a shaped-charge warhead, such as a rocket propelled grenade (RPG).  
5

Shaped-charge warheads, such as RPGs are capable of penetrating steel and armour and, therefore, pose a particular problem for tanks and armoured personnel carriers (APC) in combat situations. A shaped-charge warhead consists of a cone shaped warhead having a quantity of explosive disposed behind a hollow space. The hollow space is typically lined with a compliant material, such as copper. When detonated the energy is concentrated to the centre of the charge and it is sufficient to transform the copper into a thin, effectively liquid, shaped-charge jet having a tip speed of up to  $12\text{ kms}^{-1}$ . The extremely high pressures generated cause the target material to yield and flow plastically, with devastating effect. To be most effective the shaped-charge has to detonate at the correct distance from the target. If it detonates too close to the target the shaped-charge jet will not have properly formed before hitting the surface and the effect will be lessened. Conversely, if the shaped-charge is detonated too far away from the target surface the shaped-charge jet will have diffused and, again, the effect is lessened.  
10  
15

20

The fact that shaped-charge warheads must be detonated at a particular distance from the target object has been commonly utilised in defence shields. By providing a preliminary shield at a short distance from the actual armour of the vehicle, or other structure, it is possible to cause the warhead to detonate at a safe distance from the actual armour, with the effect that the charge explodes between the preliminary shield and the armour. In effect, the warhead becomes a conventional grenade, rather than a shaped-charge.  
25

30 Any preliminary shield which causes premature detonation of the shaped-charge will offer some degree of protection. The shield itself merely needs to cause detonation, it is not meant to act as additional armour. During World War II the German army fitted sheet metal skirts or "Schürzen" on to many of their tanks to act as a preliminary shield. In more recent times it

has become common to fit so-called "slat armour" to tanks and other military vehicles. The slat armour comprises a metal frame which is mounted at a distance of approximately 500mm from the vehicle. The frame comprises a plurality of horizontal struts or slats which are spaced apart at distance selected to prevent penetration by shaped-charge warheads. The slat armour functions as a preliminary shield, causing the premature detonation of shaped-charge warheads or, if caught between slats, disabling damage of the shaped-charge. Slat armour has been used by both the British Army, on the Warrior APC and the American Army, on the Stryker APC. One disadvantage of the slat armour is that it is relatively heavy and adds a great deal of weight to the already very heavy vehicle.

10

It is the object of the present invention to overcome some of the disadvantages of the prior art, or at least to offer an alternative system for counteracting the threat posed by RPGs.

According to the present invention there is provided textile armour comprising at least one textile section and corresponding supporting means, wherein the arrangement is such that the or each textile section is fully extended. The term "fully extended" describes the requirement that the or each textile section is free from sagging material when it is supported. The material should be supported at its full width, but it is not necessary for it to be taut. The reason for this requirement will be discussed in more detail below.

20

The textile armour according to the present invention is not armour in the conventional sense. Rather, it is specifically intended to be used to defend against shaped-charges, in particular to diminish the effectiveness, or cause deformation, of shaped-charges. As described above, the primary damage inflicted by a shaped-charge warhead, such as an RPG, is not caused by the explosion itself but by the shaped-charge jet which is generated. The primary function of the textile armour is to deform the nose cone of the shaped-charge, thus preventing the shaped-charge jet from forming properly. Furthermore, since the textile armour is intended to be deployed at a distance in the region of 500mm from the target object which it is protecting, even if the warhead does function, the shaped-charge jet will be partly diffused when it reaches the target object. The present invention may be incorporated into armour systems to be fitted to military vehicles, in much the same way as the conventional slat armour.

However, the present invention offers significant advantages, particularly in terms of weight reduction.

Preferably, the or each textile section comprises a net formed from a plurality of  
5 interconnecting net strands. The interconnecting net strands define a net mesh which may be of a variety of different shapes. The net mesh may be square, rectangular, triangular, circular, pentagonal, hexagonal octagonal or a combination of any of these shapes. The foregoing list is not exhaustive and the net mesh may conveniently be of any regular or irregular shape which may be formed into a net.

10

The objective of the textile armour is to prevent the shaped-charge jet from forming. When the or each textile section is in the form of a net the nose cone of the RPG will normally be received in a net mesh of the net. The nose cone is typically made from aluminum and the circumference of the net mesh will be selected such that it is smaller than the maximum circumference of the nose cone, such that the RPG cannot pass straight through the net. As it approaches the net the tip of the cone enters the net mesh. However, since the circumference of the net mesh is smaller than the circumference of the nose cone, the net mesh begins to tighten against the nose cone as it passes through, causing the net to strangulate the nose cone. As mentioned above, the nose cone is hollow and the strangulation causes the nose cone to crumple, which in turn causes the firing mechanism to fail and prevents the shaped-charge jet from forming. Once the nose cone has been strangulated the remainder of the RPG acts on the net mesh and will typically cause the mesh to break. However, the damage caused by the body of the RPG will only be that of a high speed projectile, which is not comparable to the potential damage caused by a shaped-charge. In most cases it will be necessary to repair 20 or replace the textile armour after it has been hit. This is also the case in respect of the currently available slat armour.

It is preferred that the or each net section is supported at or near at least two adjacent corners, such that the body of the net hangs below. Extensive testing has revealed the surprising result 30 that the net does not require to be securely supported in order to be effective. In a typical example, a RPG will be travelling at velocities up to  $300\text{ms}^{-1}$ . Without wishing to be bound

by theory, it is believed that in the time-frame in which the net acts on the nose cone, the cone will be strangulated before the load has had a chance to be transferred to the perimeter of the net. In tests conducted using slow motion cameras it has been possible to view the interaction between the net and the RPG. As mentioned above, the nose cone crumples when the net mesh tightens around it. This renders the fuse inoperable and prevents formation of the shaped-charge jet. The remainder of the RPG then breaks through the net. It has been shown that at lower projectile velocities (in the region of  $150\text{ms}^{-1}$ ) the RPG may be "caught" by the net and catapulted back. However, in order for this to happen the net must be securely supported by a strong frame.

10

The net strands may conveniently comprise plastic fibres. It is preferred that the plastic fibres are synthetic plastic fibres and have one or more of the following properties: high tenacity; low elongation; high strength to weight ratio; low density; and soft finish. As will be discussed in more detail below, it is desirable for the net strands to be thin. Consequently, suitable fibres must be high strength and high tenacity in order to perform the desired function. Similarly, the fibres must be made of a relatively low elongation material. If the fibres were made of a high elongation material then they would stretch on impact and may allow the nose cone to pass through and impact with the target. In order to improve handling it is desirable for the textile armour to be as light as possible.

15

20

Extensive testing has revealed that it is desirable for the fibres to be high strength but with a "soft and fluffy" finish. Although the term "soft and fluffy" does not describe technical features of the fibres it describes a desirable characteristic of them. In the event that a nose cone of a RPG hits one of the net strands directly it is preferred that the fibre is deflected and the nose cone continues into a net mesh, rather than firing and forming a shaped-charge jet. If the net strand has a "hard" finish then the possibility exists that the RPG will fire. It is therefore preferred that the fibres do not have a "hard" or resilient surface finish.

25

30

Although it is desirable for the fibres to have a "soft" finish, they must also be high strength and high tenacity as they need to be capable of strangulating the nose cone of a shaped-charge warhead before they fail. The net strands may suitably comprise ultra high molecular weight

[REDACTED]

polyethylene fibres, such as Dyneema®. Alternatively, the net strands may be made from other high-strength man-made fibres, such as Kevlar®, Spectra® or any other suitable material.

5 Traditional nets tend to have knotted intersections where net strands are knotted in order to form the net mesh. It has been discovered that these knots form so-called "hard" surfaces which may cause a RPG to fire if it impacts directly onto the knot. Consequently, if a knotted construction is used then it is preferred that the knot is as small as possible to reduce the likelihood of a direct hit occurring.

10 The net preferably comprises a knotless mesh construction. Alternatively, the net may comprise a woven construction. In both of these constructions the intersections between nets strands are much less likely to cause a shaped-charge to fire if a direct hit occurs. It is believed that the particular construction of the net does not play any particular role in 15 disabling the shaped-charge. The only consideration for the net construction is that the intersections are as small and "soft" as possible.

As discussed above, the primary function of the net strands is to strangulate the nose cone of 20 a shaped-charge warhead and prevent it from firing. In order to perform this function it is preferred that the net strands are as thin as possible in order to increase the likelihood of the nose cone entering one of the net meshes, rather than hitting one of the net strands. It is a requirement of the invention that the net is "fully extended". The term "fully extended" describes the requirement that net is free from sagging material when it is supported. If the net material was permitted to sag then it would tend to bunch up, thus increasing the 25 likelihood of a warhead hitting the net strands. Consequently, the net material should be held at its full extension, although it need not necessarily be taut.

As mentioned above, it is conceivable that if the tip of the nose cone hit directly onto one of 30 the net strands then this may cause the RPG to fire. However, even if this was to happen the textile armour would still provide some protection as it will normally be located at least 50cm from the target object which it is shielding. Consequently the shaped-charged jet will be

formed at least 50cm from the target and its effectiveness will be decreased.

It is preferred that the net strands have a diameter of less than 10mm. More preferably, the net strands may have a diameter of less than 6mm. The only limiting factor to the diameter of the net strands is the availability of materials from which to manufacture them. Ideally the net strands will have as small a diameter as possible. Using currently available materials it is preferred that the diameter of the net strands is in the range from 3-5mm. As technology advances it is envisaged that it will be possible to utilise net strands having a diameter of less than 3mm. The dimensions of the net strands are measured in accordance with BSI Aerospace Series Standard BS6F 100:1998.

As discussed above, the object of the textile armour is to disable a shaped-charge warhead, such as a RPG. This is achieved by strangulating the nose cone of the RPG, thus preventing it from firing. A number of different RPGs are currently available and it envisaged that over time more will be developed. The size of the warhead tends to vary between different RPGs. For example, a RPG-7 propels a warhead with a diameter of 85mm and a RPG-18 propels a warhead with a diameter of 64mm. Although a general form of the textile armour will be capable of disabling more than one size of warhead, such as the RPG-7 and the RPG-18, it is preferred that the textile armour is selected to counteract the specific threat, i.e. an RPG-7 specific textile armour.

It is preferred that the circumference of each individual mesh section of the net is less than the maximum circumference of the RPG warhead. This ensures that the RPG cannot pass straight through the net mesh. Each individual mesh section is defined as the shape defined by the intersection of the net strands. As discussed above, the mesh may be a variety of shapes, such as square, rectangular, triangular, circular, pentagonal, hexagonal octagonal or any combination of these shapes. The circumference of the net mesh is the total distance around the perimeter of the net mesh. For example, in a square net mesh with sides of 45mm the circumference will be 180mm.

30

It is further preferred that the circumference of each individual mesh section is less than, or

equal to, two-thirds of the maximum circumference of the RPG warhead. This has been found to be the optimum mesh size which allows for as open a net as possible, while ensuring that the net is capable of strangulating the nose cone of an RPG warhead. It is believed that if the circumference of the mesh section is greater than two-thirds of the maximum circumference of the RPG warhead, then the possibility exists that the warhead will pass through the net and impact with the target object. It is also desirable to have as open a net as possible in order to minimise the likelihood of the warhead impacting with the net strands. Consequently, it has been discovered that the optimum circumference of each mesh section is two-thirds of the maximum circumference of the nose cone of the RPG which the net is designed to disable.

10

As discussed above the RPG-7 propels a warhead with a maximum diameter of 85mm. The maximum circumference of such a warhead will be approximately 267mm. Consequently, the optimum circumference of each mesh section in a textile armour designed to counteract the RPG-7 would be approximately 178mm. In the case of a square net mesh this would require sides of approximately 45mm. In the case of a square or rectangular net mesh the sides will typically be in the range from 20-100mm.

15

It is preferred that the supporting means comprises a rigid support member. As discussed above, the net only requires minimal support in order to function. However, a rigid support member helps to ensure that the net is held in a "fully extended" manner. The rigid support member may conveniently be a frame structure.

20

The support member may be of a variety of shapes and its primary function is to suspend the textile section in order to provide a shield for a target object, such as a tank or APC, a building, a stockpile of munitions, a person or persons or anything else which may be subjected to enemy fire. The rigid support member may conveniently be a frame structure. The frame structure may be square, rectangular, circular, triangular, arched, pentagonal, hexagonal or any other regular or irregular shape which is capable of supporting a textile section. For example, the frame structure may comprise two upright posts connected by a cross bar.

25

30

The textile section may be suspended from a portion of the support member, such that it hangs down, or it may extend between two points on the support member, such that it is held taut.

5 It is preferred that the textile section is attached to the supporting member at a plurality of attachment points, and more preferred that the attachment points are evenly spaced along the supporting member.

10 The attachment between the textile section and the supporting member may be effected using any suitable attachment means, as will be easily understood by the person skilled in the art. The attachment may be permanent, semi-permanent or breakaway, and each attachment type has different properties which will be selected by the user. As discussed above, the primary objective for armour designed to counteract RPGs is to disable the warhead.

15 Although the net does not require support to function it is preferred from an operational point of view. It is envisaged that the textile armour will be fitted to armoured personnel carriers (APC) and the like in a similar manner to conventional slat armour. Fitting and replacement of the textile armour will be more easily facilitated if the textile armour is held within a frame. Although the frame need not provide support for the net in disabling RPGs, it must be 20 strong enough to handle the daily wear and tear to which it will be subjected. For example, when it is fitted to an APC it is likely that the frame will be utilised by soldiers to enable them to climb on top of the APC.

25 In order to improve the functionality of the textile armour system it is preferred that the textile sections are provided with a camouflage colouring. More preferably, the textile sections may also be provided with a suitable camouflage garnish to compliment the colouring of the surroundings in which the system will be used. The use of such camouflage is well known.

30 According to a second aspect of the present invention, there is provided a textile armour system comprising a plurality of textile sections and a plurality of corresponding supporting

means, wherein the arrangement is such that each textile section is fully extended.

The plurality of supporting means may conveniently comprise frame structures which may be connected together to form a framework of interconnected support members. The support  
5 members offer structural and inertial support for the system. The framework may be anchored to the ground, vehicle or other structure by any suitable means or secured in any other suitable way. The framework must be capable of providing the necessary support under impact from projectiles, such as RPGs. Although the textile armour is capable of disabling an RPG without support from a frame structure it has been shown that at lower velocities a  
10 frame structure can be helpful.

The textile armour system preferably comprises textile armour as described above. The textile armour system may conveniently be used to provide a screen between a target object and an incoming projectile. The target object may be a vehicle such as a tank or APC, a building, a  
15 stockpile of munitions, a person or persons or anything else which may be subjected to enemy fire. Although the system is specifically intended to be utilised to diminish the threat from shaped-charges, it may be deployed against other projectiles.

For a better understanding of the present invention reference will now be made to the  
20 accompanying drawings showing solely by way of example, an embodiment of the invention and, in which:

Fig. 1 shows a front view of a textile armour;

25 Fig. 2 shows a schematic sectional view of the textile armour of Fig. 1, before impact of a RPG warhead; and

Fig. 3 shows a schematic sectional view of the textile armour of Fig. 1, after impact of a RPG warhead.

30 Referring firstly to Fig. 1, this shows a front view of a textile armour 2. The textile armour 2

[REDACTED]

comprises a textile section, in the form of a net mesh 4 formed by a plurality of interconnected net strands 5, 6, and supporting means in the form of a frame 7. The net strands 5, 6 forming the net mesh 4 are made of a high-performance polyethylene fibre manufactured by DSM and sold under the Dyneema® brand. It is preferred that the net strands are manufactured from plastic fibres having one or more of the following properties: high tenacity; low elongation; high strength to weight ratio; low density; and soft finish. Ideally, the plastic fibres will have all of the listed properties. The net strands 5, 6 must be sufficiently strong to ensure that the nose cone of an RPG is strangulated before they fail. The operation of the textile armour 2 will be described in more detail with reference to Fig. 3.

10 Similarly, the net strands 5, 6 must exhibit relatively low elongation in the time frame in which they act on the nose cone. Typically, the textile armour 2 will be deployed at a distance of 500mm from a target object and it is important that the net strands 5, 6 do not stretch under loading to the extent that an RPG could hit the target object before the textile armour 2 has acted to disable it.

15 Any suitable high-strength yarn may be used, in particular high-strength man-made fibres. For example, the net strands may be made from other high-strength man-made fibres, such as Kevlar®, Spectra® or any other suitable material which exhibits the desired properties. As discussed above, it is desirable for the net strands to have a "soft" finish. This does not mean that the net strands will break when hit by a high velocity projectile, rather it means that the projectile will push the net strand aside easily.

20

The net mesh is a square mesh with a mesh knot to knot size, or mesh dimension, of approximately 45mm. The mesh knot to knot size must be small enough to ensure that RPGs are not permitted to pass through the net mesh 4 and this requirement will be discussed in more detail below. Although the mesh dimension is defined in relation to the "mesh knot to knot size", the net is actually constructed using a knotless intersection construction. The knot to knot size merely refers to the dimension of one side of the square net mesh. Although a square net mesh is utilised it is possible to manufacture the textile armour 2 using any shaped mesh, so long as the mesh size permits the textile armour 2 to function.

25

30

The operation of the textile armour 2 will be described in more detail in relation to Figs. 2 and 3. However, a key feature of the textile armour 2 is the size of each individual mesh section. Each individual mesh section is defined as the shape defined by the interaction of the net strands 5, 6, which is square in the present case. Although the textile armour 2 may be utilised to counter the threat posed by more than one size of RPG, each net will be most effective against a particular size of RPG. In order to disable an RPG the textile armour 2 must be able to strangulate the nose cone. Consequently, the circumference of each section of net mesh is preferably no greater than two-thirds of the maximum circumference of the particular RPG.

10

In the present example the textile armour 2 is designed to disable an RPG-7 warhead. The RPG-7 warhead has a maximum diameter of 85mm and a circumference of approximately 267mm. In order to ensure that the warhead is disabled the circumference of each individual mesh section must be approximately 178mm, which equates to a square mesh with sides of approximately 45mm. Alternatively, it would be possible to use a rectangular mesh with sides of 60mm and 30mm.

15

The braid diameter of the net strands is 4.5mm. It is preferred that the diameter of the net strands is as small as possible to limit the possibility of an RPG hitting a net strand.

20

The net mesh 4 is attached to a frame 7 by any suitable means. The net mesh is attached to the frame 7 at a plurality of points around the inner periphery of the frame 7. Testing has shown that at most velocities the frame structure 7 plays no part in disabling the RPG warhead. In fact, it is believed that at a velocity of  $300\text{ms}^{-1}$  the warhead is disabled and the RPG has broken through the net mesh 4 before the load is transmitted to the frame 7. The frame 7 is manufactured from box steel. Although it plays no part in disabling the warhead it is preferred that the frame 7 is strong and resilient as it will typically be deployed in war time situations, such as additional armour for an APC, and it is likely to be subjected to some rough treatment, e.g. soldiers will climb on it. The frame 7 is provided with means (not shown) for connecting it to further frames in order to create armour of varying sizes to suit different applications. The frames 7 must be easy to replace as they will require repair when

hit.

Referring now to Fig. 2, a RPG 12, is shown travelling towards the textile armour 2, in a direction perpendicular to the plane of the textile armour 2. The textile armour 2 is deployed  
5 at a distance of 500mm from the target object 10, which may be an APC. The operation of the textile armour 2, as a result of the impact of the RPG 12, will be described with reference to Fig. 3.

10 Fig. 3 shows the result of the impact of a RPG 12. The RPG 12 is an RPG-7 and has a maximum diameter of 85mm and a typical velocity of  $300\text{ms}^{-1}$ . As discussed above, the nose cone of an RPG is hollow and is typically made from aluminium. The net strands 5, 6 of the net mesh 4 are very thin and there is more fresh air than material in the textile armour 2. This means that in normal circumstances there is a far greater likelihood that the tip of the nose cone 11 of the RPG 12 will enter into the space defined by a net mesh 4, rather than hit one of  
15 the net strands 5, 6. The circumference of each individual mesh section is approximately two-thirds of the circumference of the RPG 12. As the nose cone 11 passes through the net mesh it will reach a point at which the net mesh begins to tighten around it. The net mesh is made of high strength, high tenacity material and as it tightens it will strangulate the nose cone 11,  
20 causing it to crumple. This renders the RPG 12 inoperable and prevents it from firing and generating a shaped-charge.

The remainder of the RPG will then act on the net mesh and will eventually cause it to break.  
It is believed that this happens before the load can act on the frame structure 7. It will be  
25 necessary to replace the textile armour 2 after it has been hit.

In an alternative scenario the RPG 12 may hit directly onto one of the net strands 5, 6. The net strands 5, 6 are manufactured from a low density material with a "soft" finish and it is believed that when a direct hit occurs the net strand 5, 6 deforms out of the path of the RPG  
30 12 tip and allows it to continue into a net mesh 4.

The textile armour 2 may be combined with other frame sections 7 to form a larger textile armour system. The textile armour system of the present invention is a versatile system which may be adapted to suit the needs of the user. The basic components of textile sections 4 attached to support members 7 may be combined in a variety of different ways to provide protection for a variety of objects 10. The many possible variations will be easily understood by the skilled person and the given examples merely show one possible embodiment.

5

Claims

1. Textile armour comprising at least one textile section and corresponding supporting means, wherein the arrangement is such that the or each textile section is fully extended.

5

2. Textile armour according to claim 1, wherein the or each textile section comprises a net formed from a plurality of interconnecting net strands.

3. Textile armour according to claim 2, wherein the or each net is supported at or near

10 two adjacent corners, such that the body of the net section hangs below.

4. Textile armour according to claim 2 or claim 3, wherein the net strands comprise plastic fibres.

15 5. Textile armour according to claim 4, wherein the plastic fibres have one or more of the following properties: high tenacity; low elongation; high strength to weight ratio; low density; and soft finish.

20 6. Textile armour according to claim 4 or claim 5, wherein the net strands comprise ultra high molecular weight polyethylene.

7. Textile armour according to any one of claims 2-6, wherein the net comprises a knotted construction.

25 8. Textile armour according to claim any one of claims 2-6, wherein the net comprises a knotless mesh construction.

9. Textile armour according to any one of claims 2-6, wherein the net comprises a woven construction.

30

10. Textile armour according to any one of claims 2-9, wherein the net strands have a

[REDACTED]

diameter of less than 10mm.

11. Textile armour according to claim 10, wherein the net strands have a diameter of less than 6mm.

5

12. Textile armour according to claim 11, wherein the net strands have a diameter in the region from 3-5mm.

10 13. Textile armour according to any preceding claim, wherein the armour is configured to disable a shaped charge warhead.

14. Textile armour according to claim 13, wherein the shaped charge warhead is a rocket propelled grenade.

15 15. Textile armour according to claim 13 or claim 14, as dependent on any one of claims 2-12, wherein the circumference of each individual mesh section is less than the maximum circumference of the nose cone of the shaped charge warhead which the net is designed to disable.

20 16. Textile armour according to claim 15, wherein the circumference of each individual mesh section is less than, or equal to, two-thirds of the maximum circumference of the nose cone of the shaped charge warhead.

25 17. Textile armour according to any preceding claim, wherein the supporting means comprises a rigid support member.

18. Textile armour according to claim 17, wherein the rigid support member is a frame structure.

30 19. Textile armour according to claim 17 or claim 18, wherein the textile section is attached to the support member at a plurality of attachment points.

20. Textile armour according to claim 19, wherein the attachment points are evenly spaced along the support member.
21. Textile armour according to any preceding claim, wherein the or each textile section is provided with a camouflage colouring.  
5
22. Textile armour according to any preceding claim, wherein the or each textile section is provided with a camouflage garnish.
- 10 23. Textile armour according to any preceding claim, wherein the textile armour is capable of disabling a projectile with a velocity up to  $300\text{ms}^{-1}$ .
24. A textile armour system comprising a plurality of textile sections and a plurality of corresponding supporting means, wherein the arrangement is such that each textile section is supported in a substantially wrinkle-free manner.  
15
25. A textile armour system according to claim 24, wherein the supporting means comprise rigid frames, each frame being connected to another frame.
- 20 26. A textile armour system according to claim 25, wherein the frames provide structural and inertial support for the system.
27. A textile armour system according to any one of claims 24-26, comprising textile armour according to any one of claims 1-23.
- 25  
28. A textile armour system according to any one of claims 24-27, wherein the system is deployed to provide a screen between a target object and an incoming projectile.

**Abstract**

**TEXTILE ARMOUR**

Textile armour (2) comprising at least one textile section (4) and corresponding supporting means (6), wherein the arrangement is such that the or each textile section is fully extended.

5

(Fig. 1)

Fig. 3

10

1/3

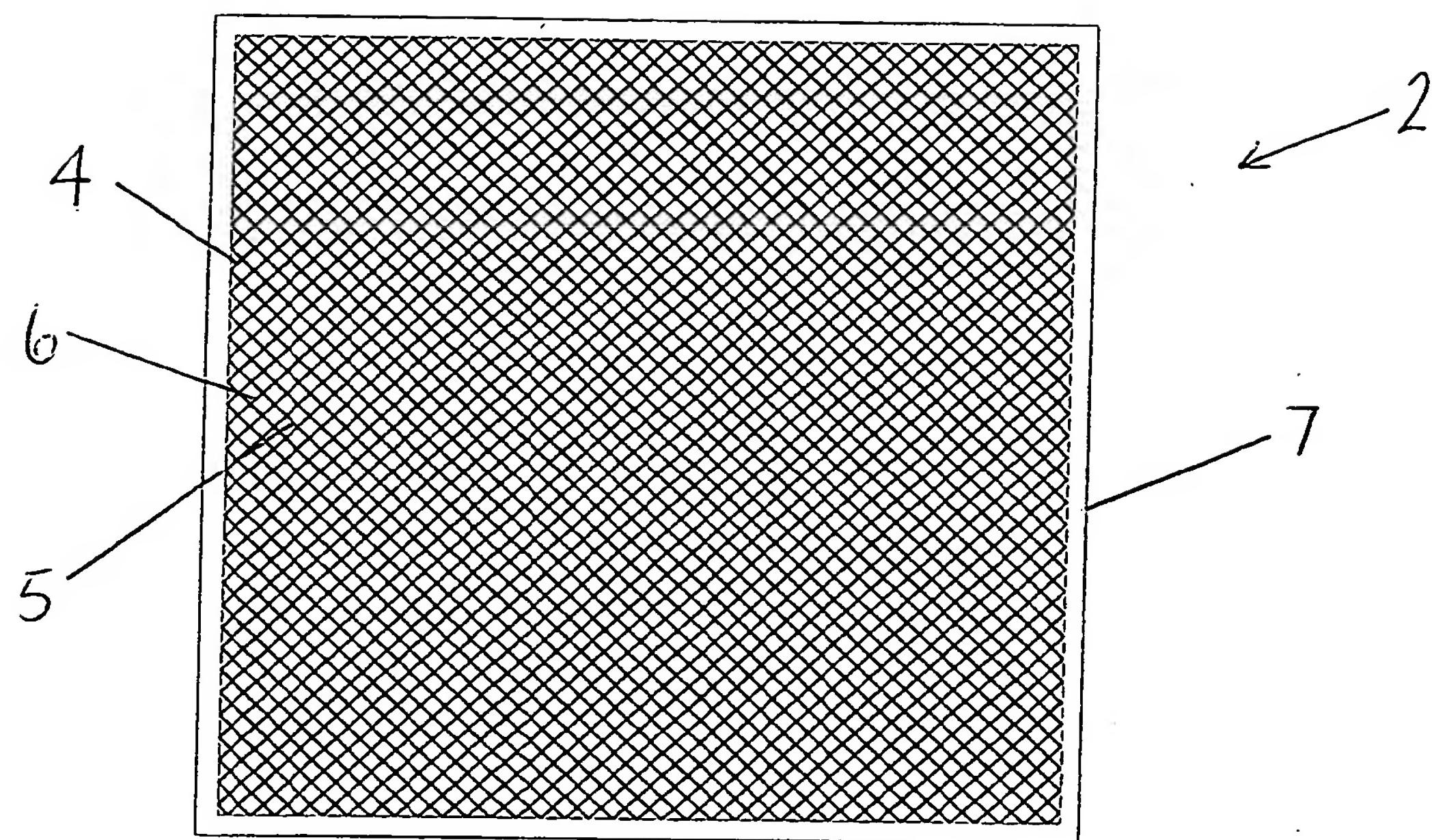
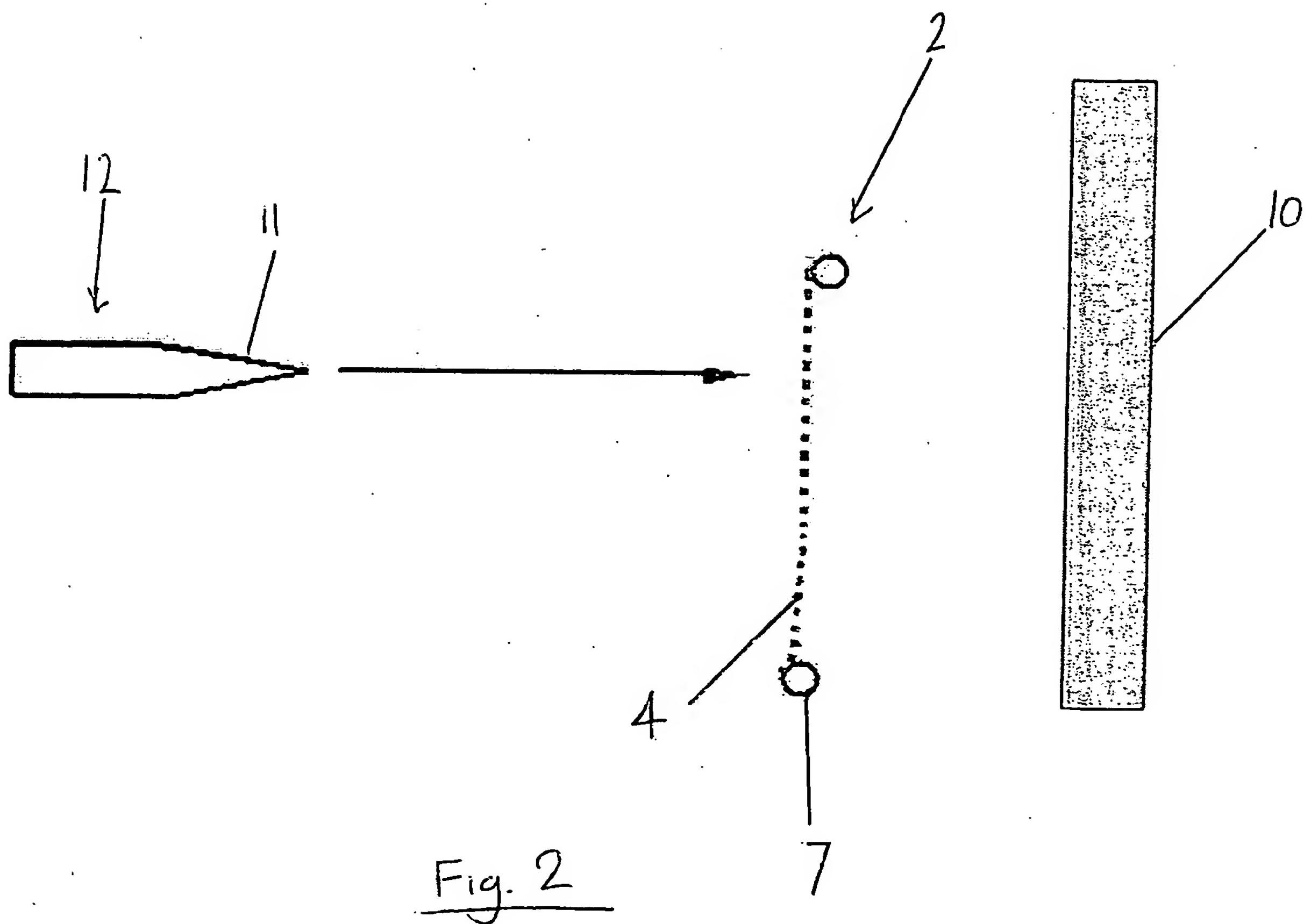


Fig. 1

2/3



3/3

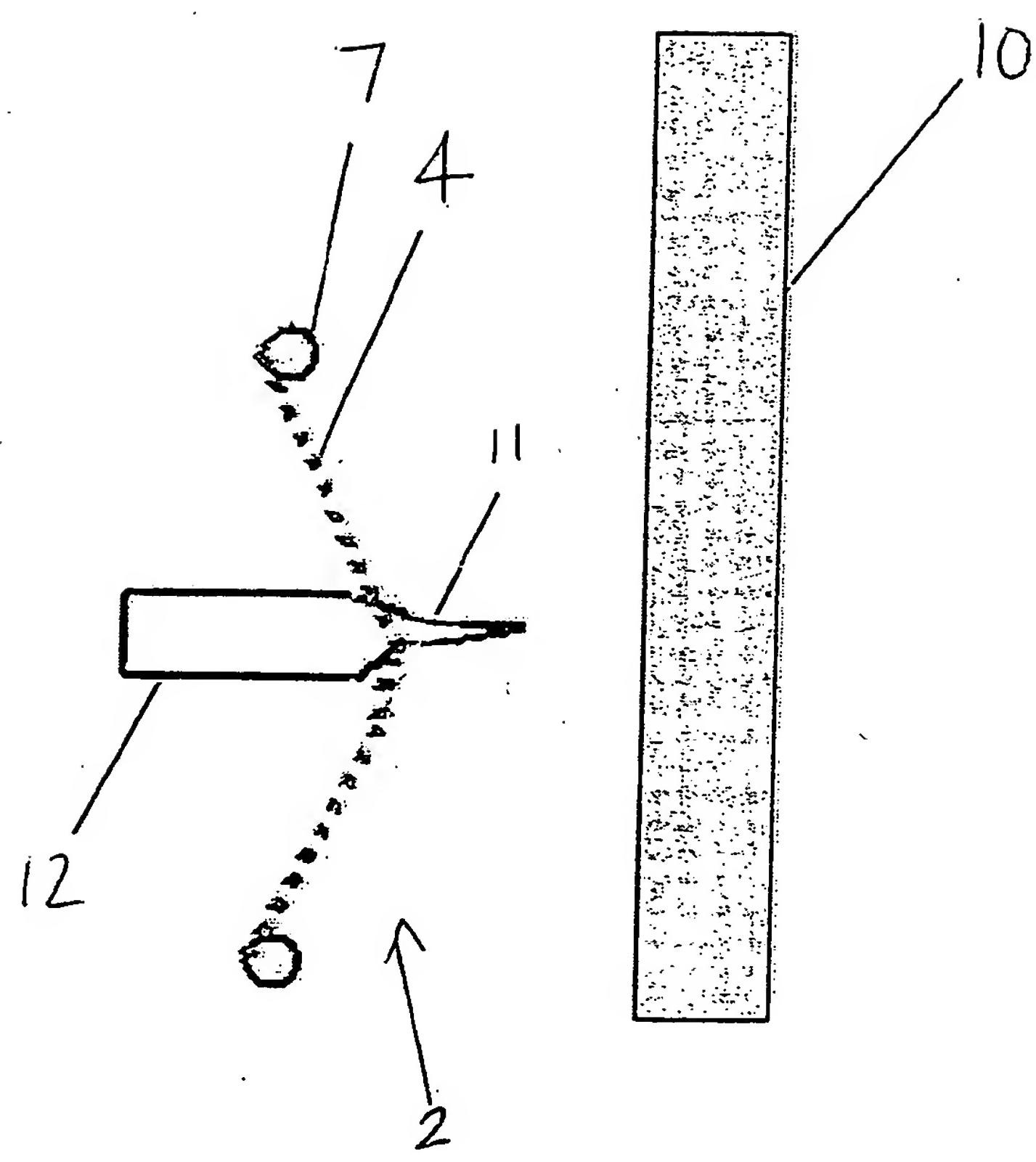


Fig. 3